An Examination of a Brushing Program for a Child with Sensory Sensitivity

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ABSTRACT

Behaviors associated with sensory integration difficulties are often problematic in the home and school settings. Children who struggle with this problem may display behaviors such as inattention, disruption, and the avoidance of certain activities. Historically, occupational therapists primarily implemented sensory integration interventions. However, parents and educators are beginning to recognize this problem and are requesting information about interventions that can be implemented in the home and classroom. Researchers do not agree on the effectiveness of sensory integration interventions. As a result, the purpose of this study was to examine the effectiveness of a specific intervention (The Wilbarger Protocol) for a child with sensory sensitivity in her natural setting. The Wilbarger Protocol delivers therapeutic deep pressure and proprioception input through the use of a specialized brush, and is often called a "brushing program." To determine whether the intervention program was effective, a single-

factor reversal (ABAB) design was implemented. Results showed a decrease in the subject's target behavior, but it is not clear whether the decrease was a result of the intervention.

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Chapter One: Introduction

Sensory integration a construct in the field of occupational therapy since the 1960s, has recently become a common topic of interest to many parents and educators. Dr. Jane Ayres was the first to coin the term *sensory integration*, and called it "the neurological process that organizes sensation from one's own body and from the environment and makes it possible to use the body effectively within the environment" (1972, p. 11). Through her research, Ayres discovered that there are several systems involved in sensory integration including visual (sight), auditory (hearing), olfactory (smell), gustatory (taste), vestibular (movement and balance), proprioception (joints and muscles), and tactile (touch). These sensory systems allow us to interpret incoming stimuli from the environment and use it to react and plan behavior (Kranowitz, 1998). This research will focus on the tactile system.

The tactile system is related to the nerves under the surface of the skin and the information they send to the brain. This information can come from touch, pain, temperature, and pressure (Hatch-Rasmussen, 2005). A child may be considered tactilely defensive when he or she displays "the tendency to react negatively and emotionally to touch sensations" (Ayres, 1972; Sears, 1981). Current philosophies behind sensory integration suggest that tactile defensiveness is due to "failure of higher central nervous system structures to modulate incoming tactile stimuli" (Royeen & Lane, 1991). Children with tactile defensiveness are overly sensitive to light touch. Behaviors associated with tactile defensiveness include withdrawal when being touched, refusal to eat certain foods, refusal to wear certain types of clothing, avoidance of getting hands dirty, complaining when having face washed, and using only fingertips instead of the whole hand to manipulate objects (Hatch-Rasmussen, 2005). In addition, children who are

sensitive to light touch also seek out and crave deep touch such as "bear hugs" and back rubs (Kranowitz, 1998).

Behaviors associated with tactile defensiveness are often problematic in the home and school settings (Kranowitz, 1998). These behaviors can impede a child's academic and social functioning, and even impair the child's development. For example, if the child is only eating particular foods, he or she may not get an adequate amount of vitamins and minerals. Also, many activities within a school setting require students to get their hands dirty such as art projects or playground activities. It may be difficult for teachers to make exceptions for these children. Furthermore, because children with tactile defensiveness crave deep touch, they can often be very disruptive as they seek out ways to obtain that type of stimulation. These children may give "bear hugs" at inappropriate times, push, or lay on top of others, all of which can be disturbing for other children and adults around them. Consequently, it is important to find ways to help children deal with sensory difficulties in order to help them function socially both in school and in the community.

Occupational therapists aim to design interventions which slowly introduce different textures and types of touch into the daily lives of those children with tactile defensiveness. There is much controversy surrounding the effectiveness of these interventions. Early reports on sensory integration were based on poorly controlled studies (Mulcahy, 1994). Today, sensory integration is still criticized because there is a lack of empirical research showing whether interventions are actually effective. (Miller, Schoen, James & Schaff, 2007; Mulcahy, 1994; Ottenbacher, 1982; Vargas & Camilli, 1999). Research regarding sensory integration has produced contradicting results. Many professionals believe that sensory integration interventions are extremely effective with children who have sensory integration difficulties, while others are

skeptical. Ottenbacher (1982) conducted a meta-analysis of eight studies and found positive effects overall. However, all of the studies were conducted before 1980. Further, Vargas and Camilli (1998) conducted a meta-analysis of sixteen studies from 1972 to 1998 and found that early studies found positive effects of sensory integration treatment, while later studies did not show positive effects. Therefore, further research needs to be conducted in order to discover whether sensory integration techniques are effective.

One approach to sensory integration is the Wilbarger Protocol, which was developed by Patricia and Julia Wilbarger in 1991. This protocol involves a comprehensive, individualized program based on the belief that certain repeated sensory experiences can reduce sensory or tactilely defensive symptoms (Bundy, Lane, & Murray, 2002). Some of these experiences include deep pressure, muscle resistance activities, joint compression and vestibular input (Wilbarger & Wilbarger, 1991; Ayres, 1972). These experiences are thought to help children adapt to sensory input by influencing the central nervous system. The Wilbarger Protocol is a professionally guided program which utilizes the therapeutic application of deep pressure through the use of a specific type of surgical brush, which will not cause friction (Wilbarger & Wilbarger, 2002). Application of deep pressure is followed by joint compressions in the trunk, arms, and legs. Although the concept is simple, administrators need to be trained by a certified occupational therapist in order to deliver the program appropriately and safely.

There is very little research indicating whether the Wilbarger Protocol has an impact on sensory integration or children's behavior related to sensory dysfunction. Often times, the protocol is just one of many techniques being used with a child, so it may be difficult to decipher which technique has the greatest impact on the child's behavior. It is important to conduct more studies in this area to better understand the true effectiveness of the protocol.

Many of the techniques occupational therapists use to help children overcome tactile defensiveness, including the Wilbarger Protocol, have only been studied in clinical settings, and sensory integration techniques are applied most frequently within the clinical setting where problematic behaviors may or may not occur (Dunstan & Griffiths, 2008). Application of techniques during an occupational therapy session in a clinic, where the behavior likely does not occur, makes it difficult to understand the impact of the technique on the behavior. Further, Dunstan and Griffiths pointed out that the nature of occupational therapy intervention has shifted to be more family-centered. Families and schools are more involved with planning and implementing interventions. As a result, it is necessary to study the effectiveness of the techniques within more natural settings, such as in schools and homes.

However, having parents, teachers, and aides administer techniques can create further difficulties when implementing interventions or studying the effects of them. When implemented by caregivers, the techniques may not be applied in a systematic way with fidelity. Because the teachers, parents, or aides might not be adequately trained, they might administer the techniques in a haphazard manner and not fully understand the timing and intensity of these techniques. Therefore, more research needs to be conducted in children's natural settings using systematic approaches to fully understand the impact on children's behavior.

Purpose of the Study and Research Questions

Given that current research in the area of sensory integration has produced contradicting results and that most of the research has been conducted within the clinical setting, the purpose of this single-subject study is to examine the impact of a brushing program on the behavior of a child with tactile defensiveness in her natural setting. The following questions will guide this research paper:

1. What degree of variability did the target behavior show across baseline and treatment conditions?
2. What was the level of the target behavior across baseline and treatment conditions?
3. What trends did the target behavior demonstrate across baseline and treatment conditions?
4. Was the Wilbarger Protocol effective on the target behavior?

Definition of Terms

Central Nervous System - "The part of the nervous system, consisting of the brain and spinal cord, that coordinates the activity of the entire nervous system" (Kranowitz, 1998).

(Mean) Level - "value on the vertical axis scale around which a set of behavioral measures converge" (Cooper, Heron, & Heward, 2007, p. 150).

Modulation - the brain's regulation of its own activity and activity level.

Occupational Therapy - The use of productive or creative activity in the treatment or rehabilitation of people with physical, emotional, or cognitive disabilities.

Praxis- Related to the ability to plan new movements (Bundy et al., 2002).

Proprioception - "The unconscious awareness of sensations coming from one's joints, muscles, tendons, and ligaments" (Kranowitz, 1998).

Sensory Defensiveness - ". . . a constellation of symptoms related to aversive or defensive reactions to non-noxious stimuli across one or more sensory systems." (Wilbarger & Wilbarger, 1991).

Sensory Diet - the therapeutic use of sensation incorporated into daily activities (Wilbarger & Wilbarger, 2002).

Sensory Integration - ". . . the neurological process that organizes sensation from one's own body and from the environment and makes it possible to use the body effectively within the environment" (Ayres, 1972, p.11).

Sensory Integration Dysfunction (SID) - The inability to process sensory information and use it in a meaningful, organized manner.

Single-Subject Research - Research that focuses on the relationships between stimuli in the environment and the subsequent responses of individuals (Richards, Taylor, Ramasamy, & Richards, 1999).

Tactile Defensiveness (TD) - ". . . the tendency to react negatively and emotionally to touch sensations" (Ayres, 1972; Sears, 1981).

Trend - ". . . the overall direction taken by a data path. . . is described in terms of their direction, degree of magnitude, and extent of variability of data points around the trend" (Cooper et al., 2007, p. 151).

Variability - How often and the extent to which multiple measures of behavior yield different outcomes (Cooper et al., 2007).

Visual Analysis - ". . . a systematic form of examination used to interpret graphically displayed data" (Cooper et al., 2007, p. 149).

Wilbarger Protocol - "a comprehensive, intensive and individualized sensory integration program…involving deep pressure and joint compressions" (Wilbarger & Wilbarger, 2002).

Chapter II: Literature Review

Everyday, human beings receive information through their senses from their environment and from within their bodies. Information is received via several sensing systems including visual (sight), auditory (hearing), olfactory (smell), gustatory (taste), vestibular (movement and balance), proprioception (joints and muscles), and tactile (touch). These systems are complex and allow us to experience and interpret incoming stimuli. However, these systems do not work efficiently for every person, often times resulting in "sensory integration dysfunction" or SID (Kranowitz, 1998).

SID is the inability to process sensory information and use it in a meaningful, organized manner (Kranowitz, 1998). All people occasionally experience difficulty processing sensory information. Illness, fatigue, and stress can interfere with smooth sensory integration. However, it is only considered a problem when the difficulty starts to affect several aspects of a person's life. Specifically, children with learning disabilities, attention deficit hyperactivity disorder (ADHD), fetal alcohol syndrome (FAS), severe cognitive disabilities, autism and pervasive developmental disorders have been thought to frequently have problems with sensory processing (Kranowitz, 1998). When sensory integration processes are working efficiently, attention can be given to the task at hand, and movements are coordinated in a useful and efficient manner (Bakley, 2001). Conversely, a person with sensory integration dysfunction may act confused, distracted, and disorganized. Coping with everyday tasks can be frustrating and difficult.

- Several causes of sensory integration dysfunction have been hypothesized, but researchers do not have any conclusive evidence. Some proposed causes include a genetic predisposition, prenatal issues including chemical use, prematurity, trauma during birth,

environmental pollutants, and excessive or insufficient sensory stimulation after birth (Kranowitz, 1998).

Sensory Integration Theory

Throughout her career, occupational therapist Dr. A. Jean Ayres sought to describe atypical social, emotional, motor, and functional patterns of behavior that were related to poor processing of sensory stimuli (Miller, Cermark, Lane, Anzalone, & Koomar, 2004). In 1972, she was the first to coin the term "sensory integration" and defined it as "the neurological process that organizes sensation from one's own body and from the environment and makes it possible to use the body effectively within the environment." (Ayres, 1972, p. 11). Once the brain interprets sensory information, it triggers responses such as physical actions, thoughts, or feelings (Bakley, 2001).

Ayres' theory has been used for several purposes. First, it is often used to explain the connection between the brain and behavior and why people respond to sensory input in varying ways (DiMatties & Sammons, 2003). It is also used to plan interventions for children in order to improve certain sensory processing difficulties (Bundy et al., 2002). Finally, this theory is used to predict how behavior will change as a result of intervention related to sensory integration.

Ayres believed that learning is dependent on the ability to absorb and process sensory information from the environment and use it to plan and organize behavior. She used the term "learning" in a broad sense including academic learning as well as behavior change and adaptive motor behaviors (Mulcahy, 1994). Those who have a diminished ability to process sensory information may also have difficulty producing appropriate behavior, which may in turn interfere with learning (Bundy et al., 2002). Ayres upheld the notion that the central nervous system is plastic, meaning that it can be easily molded or changed through varying activities and exercises

(1972). By introducing enhanced sensation as a part of meaningful activity, Ayres believed improvements could be made in the ability to process sensory information and, therefore, increase learning and appropriate behavior. She stressed that the period from age three to seven was critical for developing sensory integration. Unfortunately, this has often been misinterpreted to mean that older children and adults cannot benefit from sensory integration therapy, but researchers now emphasize that it can be used with persons of all ages (Pfeiffer & Kinnealey, 2003).

Sensory Integration Dysfunction

According to Ayres theory, dysfunction in sensory integration can be expressed through poor praxis, poor modulation, or a combination of both difficulties (1972). Praxis is related to the ability to plan new movements (Bundy et al., 2002). The behaviors that result from poor praxis include clumsiness, avoidance of motor behavior, and exaggerated or diminished force. These children may also display deficits in posture, gross motor tasks, and difficulty in using both sides of the body in a coordinated fashion.

Modulation refers to the brain's regulation of its own activity and activity level (Kranowitz, 1998). Kranowitz explained that modulation serves to balance the flow of sensory information coming into the central nervous system by turning neural switches on and off. Within the category of modulation difficulties, researchers have agreed on two broad types of modulation dysfunction: under-responsiveness and over-responsiveness (Ayres, 1972; Dunn, 1997).

Those who are under-responsive may seem uninterested, self-absorbed, and dull in affect. They are often said to be "overly modulated." Theorists believe that these people have a high threshold for sensory stimulation and need a high level of input in order to elicit a response.

Most daily activities do not meet the capacity of their sensory threshold, so they need added activities in order to meet their needs. Parents of children who are under-responsive are often concerned about an auditory problem because their child may not respond quickly to their name or conversation (Dunn, Saiter, & Rinner, 2002). Further, children who are under responsive are prone to injury because they may not always realize they have hurt themselves (Dunn, 1997).

Those who are over-responsive tend to react strongly to sensory stimulation and are believed to have a very low threshold for stimulation. They tend to be distractible, hyperactive and tend to withdraw, avoid, or control situations in which there are high levels of stimulation. If they are unable to avoid or control the situation, they will often lash out verbally and physically (Dunn, 1997). In schools, because of these children's difficult behaviors related to their sensory needs, often they are seen as rambunctious, resistant, or controlling.

Sensory Defensiveness and Tactile Defensiveness

The most common form of sensory modulation dysfunction is an extreme form of over-responsiveness called sensory defensiveness (Bundy et al., 2002). It has been described by Wilbarger and Wilbarger (1991) as "a constellation of symptoms related to aversive or defensive reactions to non-noxious stimuli across one or more sensory systems." Behaviorally, a person with sensory defensiveness will have a tendency to react negatively or with alarm to sensory input which is generally considered harmless or non-irritating. Children with sensory defensiveness tend to be rule-bound, ritualistic, and uncooperative. They engage in behaviors that will limit their sensory input and prefer predictable routines in which they know what type of sensory input they will be encountering (Dunn et al., 2002). They tend to be picky regarding fabrics, bathing procedures, and eating. If left untreated, sensory defensiveness can have a

negative impact on everyday life. These children will continue to avoid certain situations and consequently may have difficulty in social relationships (Stagnatti, Raison, & Ryan, 1999).

The most common type of sensory defensiveness is tactile defensiveness (TD), which is often defined as "the tendency to react negatively and emotionally to touch sensations" (Ayres, 1972; Sears, 1981). Tactile, or touch, receptors are found throughout the skin and are activated by external stimuli such as texture, temperature, pressure, and pain (Stagnatti et al., 1999). A person's reaction to these stimuli is regulated by the sense of touch, which is used continuously on a daily basis (Bakley, 2001). Ayres' (1972) stated that touch is present before birth, and many believe that it continues to be more critical to human functioning than is generally recognized (Kinnealey, 1989). Further, Kinnealey explained that child development theorists such as Piaget, Goldstein, and Bruner have all emphasized the importance of touch in cognitive and motor development. The integration of the tactile sense can be observed in a newborn child by the rooting reflex. When a baby is touched on the cheek, it will instinctively turn its head toward the stimulus.

Ayres originally believed that TD was caused by a disparity between the protective tactile function and discriminative tactile function (1972). The protective system responds to tactile stimuli with movement, alertness, and a high degree of affect. The discriminative system attends to the meaning of the environmental stimuli in order to plan an appropriate response (Sears, 1994). Ayres proposed that, in a child who has TD, the protective system predominates over the discriminative system, resulting in the interpretation of harmless stimuli as something potentially harmful (Sears, 1981). Thus, the child will react in a negative and alarmed manner. More current theories have related tactile defensiveness to a faulty behavioral inhibition system (Lane, 2002) or simply a disorder in the regulation of tactile sensory input (Stagnatti et al., 1999). The

actual cause of tactile defensiveness is unknown, but many have attributed it to genetic predisposition, prenatal issues including chemical use, prematurity, trauma during birth, environmental pollutants, and excessive or insufficient sensory stimulation after birth (Kranowitz, 1998).

Regardless of the etiology of tactile defensiveness, it appears to interfere with learning, perceptual motor abilities, and most noticeably behavior. Behaviors that are frequently displayed may include hyperactivity, avoidance of certain situations, and emotional outbursts. As a result, children with tactile defensiveness are often misdiagnosed with emotional problems, aggressiveness, and hyperactivity (Royeen & Mu, 2003). Further, a study by Kinnealey (1989) found that when compared to typical children, those with learning disabilities had significantly more difficulty with tactile functioning. Researchers speculate that tactile defensiveness may be a specific problem, but it is more likely one aspect of a more heterogeneous issue. Lane (2002) also found research indicating that tactile defensiveness could be a predisposition for later emotional problems, an extreme need for personal space, and a disruption in personal care.

Identification of tactile defensiveness is typically based upon multiple behavioral observations of the child. There are several behavioral patterns associated with TD. The child may avoid certain clothing textures, specifically those that are scratchy or rough. He or she may also display an unusual preference for certain textures, such as those that are soft or smooth, and will tend to prefer to keep his or her body well covered. This may manifest in the desire to wear long-sleeved shirts and pants, even in warm weather. The child may prefer to stand at the end of lines in order to avoid any physical contact with others. The child may show aggression to light touch or increased stress when in close physical proximity to others (Sears, 1981). Further, many children with TD will actively avoid playing activities which involve varying textures such

as play dough, finger painting, or any other activity that may be messy Also, the child will likely avoid play activities that involve body contact, which often manifests in solitary play (Lane, 2002). While a child with TD will tolerate his or her own self-touch, he or she will tend to pull away from anticipated touch from others, especially with contact near the face (Sears, 1981). The child will also likely display aversive responses to non-noxious touch such as hugging, bathing, cutting fingernails, and face washing. Conversely, a child with TD will seek out and even crave deep touch such as "bear hugs" or pushing against a wall (Kranowitz, 1998). Firm touch feels good to these children and it can even help suppress sensitivity to softer touch. Affective responses to these types of contacts are common.

It is important to note that many children will display some of these behaviors occasionally, but children with tactile defensiveness show these behaviors in a consistent, constant pattern. In addition, although their behavior seems disorganized and sporadic, children with TD seek to control situations in which tactile experiences are present (Kranowitz, 1998). By controlling these situations, the child will know when, where, and what type of tactile stimulation to expect, thereby reducing the stress that accompanies unanticipated touch.

Intervention

The primary goal of sensory integration therapy is to increase the child's participation in normal, daily activities (DiMatties & Sammons, 2003). Interventions involve using enhanced sensation in the context of meaningful, adaptive interactions. Further, Ayres' theory suggests that sensory experiences are most effective when they are incorporated into a self-selected activity that demands an adaptive response (1972). Most people naturally choose activities that meet their own sensory needs and preferences, but those with sensory integration difficulties lack the ability to obtain the proper sensory experiences to meet their needs (Wilbarger & Wilbarger,

2002). Many studies have shown that repeated and/or continuous sensory input results in lasting changes in brain function (Ayres, 1972; Wilbarger & Wilbarger, 2002). Therefore, occupational therapists have designed varying activities in order to meet the specific needs of each person's unique sensory difficulty. Further, Kranowitz (1998) and Ayres (1972) both stress the importance of early intervention. These theorists believe that it plays a key role because younger children have a central nervous system that is more flexible and can be more readily changed.

There are several key issues to consider when providing sensory integration intervention techniques. First, Wilbarger and Wilbarger (2002) noted that education is a critical first step when dealing with a child with sensory integration dysfunction. Parental education, in itself, can be therapeutic because it provides awareness and can explain the negative behaviors the child displays. Kranowitz (1998) authored a book called *The Out-of-Sync-Child* which provides parents and caregivers with practical knowledge about sensory integration dysfunction, as well as steps in diagnosing, treating and coping with associated behaviors. Researchers noted that while it is important to educate parents about sensory dysfunction, it is also important to educate the child about their issues and interventions (Dunn et al., 2002). Many have suggested talking to the child to familiarize him or her with the activity before it begins

Wilbarger and Wilbarger (2002) stressed that timing, intensity, and duration of sensory activities are also extremely important when implementing the intervention. Koomar and Bundy (2002) actually recommended that children administer the sensory activity to themselves in order to provide a positive experience. The child can choose the body part, amount of pressure, and length of time the sensation is administered. It may also be helpful to experiment with different kinds of pressure and sensation to determine which method is most effective for each child. In

1972, Ayres found that tactilely defensive clients responded best to deep pressure as well as proprioception. Ayres recommended some of the following techniques:

1. Walking with shoes and socks off on textured carpeting
2. Using wide paint brushes or textured mitts for brushing skin.
3. Wrapping Ace bandages around hands and feet.
4. Using weighted vests, backpacks, hats, and blankets.
5. Submerging body in containers of large balls, dried beans, etc.

Koomar and Bundy (2002) also noted that when applying tactile stimulation, it may be more tolerable if it is provided in the direction of hair growth. Going against the hairs may result in hyper-alertness and over-activity. In addition, these authors posited that children tend to feel more comfortable in quiet, enclosed spaces when providing sensation activities. By eliminating extraneous activity and objects, unexpected touch will be minimized.

Sears (1981) also recommended several environmental adaptations for a child with tactile defensiveness:

1. Always approach the child from the front.
2. Explain the situation before touching the child.
3. Verbally direct the child through activities.
4. Take caution not to inadvertently brush against the child.

These adaptations were recommended in order to reduce stress level in the child, as it is important to minimize sensory experiences which could potentially provoke high levels of anxiety. Whenever enhanced sensation is incorporated into an activity, it is essential to be observant of the child's responses (Koomar & Bundy, 2002). Although research indicates

expected responses from certain sensory activities, each person's response will be individually determined.

Wilbarger Protocol

Wilbarger and Wilbarger (2002) have proposed a method of intervention that addresses sensory/tactile defensiveness. Using a specialized, densely bristled brush, the Wilbarger Protocol is often called "brushing." The technique provides therapeutic deep pressure and proprioception input. This brush does not tickle or scratch, but it delivers a type of deep pressure. The brush is applied to the hands, arms, back, legs, and feet; it is never used on the stomach, groin, buttocks, head or face. The brush is generally used in the direction of hair growth. This procedure is then followed by gentle joint compressions in the trunk, arms, and legs, which delivers the proprioceptive input. This method is often prescribed by occupational therapists and usually is repeated every ninety minutes to two hours.

Wilbarger and Wilbarger (2002) offered several guidelines for implementing the technique. First, they strongly advised that only those who have received specialized training are qualified to use the method. In addition, they recommended that the technique should not be used alone as an intervention; however, it can be used in conjunction with other interventions such as a sensory diet, which was also developed by Wilbarger and Wilbarger (2002). Wilbarger and Wilbarger explain that the sensory diet involves the therapeutic use of sensation incorporated into daily activities. Activities are chosen based on the particular needs and goals for each child. Further, Wilbarger and Wilbarger believe that these activities are most successful when they are chosen and directed by the child. This method should not be used with children younger than two months or with children who have other health or physical disabilities. Finally, Wilbarger

and Wilbarger recommend using only a specific brush that is available through vendors of sensory integration equipment.

Traditionally, interventions for sensory integration difficulties were designed and implemented in a clinical setting. However, over the past few decades, the nature of occupational therapy intervention has shifted to a more family-centered model in which the child's parent and/or caregiver is more involved in the intervention process (Dunstan & Griffiths, 2008). Occupational therapists are beginning to train parents and other school staff to implement specific interventions. While an occupational therapist is likely to administer an intervention in a more controlled manner, it is important to note that children may need the intervention several times a day in order to regulate their sensory systems (Wilbarger & Wilbarer, 2002). Therefore, parents, teachers, and aides are being trained in the Wilbarger protocol so it can be administered as often as is recommended in the natural setting.

Efficacy

Ever since Ayres began publishing her theory on sensory integration therapy, its efficacy has been debated (Kaplan, Polatajko, Wilson, & Faris, 1993). Early reports were based on many poorly controlled studies. However, today sensory integration continues to be criticized because research has been unable to show why it works (Mulcahy, 1994). Miller (2003) argues that although sensory integration has not been backed by consistently positive research, it has not been proven to be ineffective either.

Many of the research studies showing the effectiveness of sensory techniques measure parents' and teachers' perceptions of change in behavior. A study by Cohn (2000) examined parents' perceptions of occupational therapy using sensory integration techniques. Most parents perceived changes in their child's abilities, activities, and sense of self-worth. They also

believed that it helped them to understand their children in a new way. A study by Kearns (2004) examined the effectiveness of art therapy using sensory integration techniques. The results indicated an increase in positive behaviors after art sessions. Another study by Mulcahy (1994) found that respondents of the surveys felt that progress using sensory integration techniques was slow, but the effects were large. Some of the noticed effects were calmness in the child, increased confidence when attempting new tasks, and improvement in coordination.

Some professionals take a maturational stance in which they believe that a child will "grow out of" the sensory integration dysfunction without treatment (Cermak & Henderson, 1990). Kaplan et al. (1993) purport that studies regarding efficacy are difficult because researchers are unable to control for maturational change. Kaplan et al. and Wilson, Kaplan, Fellowes, Gruchy, and Faris (1992) found no support favoring sensory integration therapy over other interventions such as tutoring.

In 1982, Ottenbacher conducted a meta-analysis of eight studies addressing the efficacy of sensory integration procedures. He concluded there was sufficient evidence that sensory integration was effective enough to continue its use in an educational setting. However, it is important to note that all of these studies in his meta-analysis were conducted before 1980. Further, Vargas and Camilli (1998) conducted a meta-analysis of 16 studies from 1972 to 1998. They concluded that sensory integration treatment was found to improve psychoeducational and motor performance. However, they also noted that earlier studies found more positive effects from sensory integration treatment, while later studies did not find positive effects.

Critical Analysis

It is important to look critically at the design of studies that have measured the efficacy of sensory integration procedures. Although many studies have flaws, it is important to control as

many variables possible when conducting research (Cermak & Henderson, 1990). In research concerning sensory integration, many studies have been based upon casual observation, lack an operationalized definition of sensory integration and its procedures, have been primarily studied in clinical settings, and ignore the advantages of single-subject studies. Although not all variables can be controlled, many studies lack an appropriate amount of control.

Some of the studies producing positive results are based on indirect observation of the child and not on direct measures of behavior For example, the studies by Cohn (2000) and Mulcahy (1994) examined parents' perceptions of the efficacy of sensory integration through the use of surveys. Neither study took into account actual changes in behavior. If behavior is not measured and analyzed, it is impossible to know whether the intervention was effective. To truly determine positive change in behavior, Koomar and Bundy (2002) recommended direct observation of children to see if they concentrate better, behave in a more organized fashion, and enjoy social interactions to a greater degree.

In addition, many studies lack an operationalized definition of sensory integration and/or the procedures involved (Cermak & Henderson, 1990). Sensory integration covers all human senses with varying degrees of tolerance for each sensation. Therefore, an array of interventions are linked to different types of sensory integration dysfunction. Many studies discuss sensory integration as a general topic without discriminating between different types. It is possible that some types of sensory integration procedures are not effective while others are. Therefore, researchers need to focus their studies on smaller areas of sensory integration.

Many of the techniques occupational therapists use to address sensory issues have only been studied in clinical settings (Dunstan & Griffiths, 2008). Application of techniques during an occupational therapy session in a clinic, where the behavior likely does not occur, makes it

difficult to understand the impact of the technique on the behavior. Further, Dunstan and Griffiths point out that the nature of occupational therapy intervention has shifted to be more family-centered. Families and schools are more involved with planning and implementing interventions. As a result, it is necessary to study the effectiveness of the techniques within more natural settings, schools and homes.

Research in behavior analysis most often uses a single-subject design (Cooper et al., 2007). Cooper et al. explain that in a single-subject design, the subject is exposed to repeated conditions over the course of an experiment. The subject's behavior is then measured over each phase of the study. These measures then provide the basis for comparing the effects of the independent variable as it is introduced and taken away from the study. Although some researchers believe that a study is more sound with larger numbers of subjects, Johnston and Pennypacker state that "the procedures of a (single-subject) design preserve the pure characteristics of behavior, uncontaminated by intersubject variability" (1993, p. 188). However, using a single-subject design does not produce results that can be highly generalized (Cooper et al., 2007). There currently is little single-subject research on the effects of sensory therapy.

Conclusion

Research regarding sensory integration has produced contradicting results. Many professionals believe that sensory integration interventions are extremely effective with children who have sensory integration difficulties, while others are skeptical. In addition, past practice and research has looked at sensory integration techniques in the clinical setting, but not in a more natural home or school setting. Past studies have also looked at large number of subjects or caregiver perceptions of change. It may be beneficial to add to the literature using single-subject research so that the pure characteristics of behavior can be observed (Johnston & Pennypacker,

1993). Specifically, interventions addressing tactile defensiveness should be explored in more depth.

Chapter III: Methodology

The purpose of this study is to examine the effectiveness of a brushing program for a child with tactile defensiveness. This chapter will discuss specific methods used to carry out the single-subject design study. Selection of the participant, description of the subject, data collection procedures, and data analysis will be described in detail. In addition, limitations of the study will be discussed.

Subject Selection

The researcher is a school psychologist in a large school district in Minnesota. A memo (See Appendix A) was sent out to colleagues regarding the details of the research project and the description of behaviors that may indicate difficulty with sensory integration. The memo asked colleagues to recommend a child (student or child in the community) for the study. A potential candidate included children with behaviors associated with sensory processing issues. Possible behaviors included: avoidance of scratchy or rough textures, preference for smooth or soft textures, preference for hard or deep touch, need for control in situations where they will be touched, a preference to keep body well covered, wearing pants and long-sleeved shirts in warm weather, avoidance of others'initiation of physical contact, aversive responses to hugs, bathing, fingernail cutting, face washing, and aggressive responses to contact that is otherwise considered non-irritating. A pool of three possible subjects was obtained based on the recommendation of colleagues. Out of this pool, one subject was chosen based on the parent's willingness to participate in the study. The Sensory Profile (Dunn, McIntosh, & Saiter, 2002), an instrument used to identify sensory integration difficulties, was given to the caregiver to determine the actual presence of sensory needs. The child showed significant sensory issues on the scale, and permission was obtained (See Appendix B) from the parent for the study.

Subject Description

The subject, "Sarah," was a six-year-old female kindergartner from a middle-class background. She lives with her mother, father, and younger sister. The subject's mother reported she had problems with her blood pressure during pregnancy with Sarah. She was born at 38 weeks gestation. Sarah's mother states that Sarah's sensory issues were apparent to her the moment she was born. She had a heightened sense of awareness and had feeding issues very early on. Sarah has had a long history of ear infections dating back to infancy as well. Sarah's mother reported that the Sarah is very bright and does well in school. She recently scored at the 99th percentile on state-wide standardized testing. According to her mother, Sarah's greatest needs lie in her sensory sensitivity.

The Sensory Profile was administered to the subject's caregiver in order to identify the specific needs of the subject. Because the focus of this research was to examine behavioral responses, the Behavior and Emotional Responses section of the Sensory Profile was utilized. The caregiver report indicated a "Definite Difference" in the area of Emotional/Social Responses. In other words, the subject displayed significant emotional and/or social behaviors in response to particular sensory experiences.

Other information gained from the Sensory Profile indicated that the subject "always expresses distress during grooming (for example: fights or cries during haircutting face washing, fingernail cutting)." When the caregiver was interviewed regarding her responses, she indicated the subject had extreme adverse responses to grooming activities, particularly hair brushing and tooth brushing.

Data Collection and Research Design

As with many interventions in the home and school settings, implementation of the brushing program as well as data collection and analysis required a team approach. This particular intervention needed an occupational therapist for training the subject's mother to properly administer the brushing program. It also needed a caregiver, the mother, in order to implement the brushing program in the child's natural environemnt. Finally, because psychologists have expertise in data collection and analysis, the primary researcher (a school psychologist) ensured data was properly collected and analyzed in a meaningful way.

After the results of the Sensory Profile were compiled, the target behavior was identified and operationalized. To operationalize a behavior, one must define it in terms of the operations required to measure the behavior (Bordens & Abbott, 1999). The target behavior was entitled an *adverse reaction to a grooming event* and was further defined as the following: *An adverse reaction includes one or more of the following in a given event of grooming: whining, crying, saying 'no,' physically hitting a person or object, kicking a person or object, or lashing out with one's arms or legs.* Grooming events included hair brushing and tooth brushing.

To determine whether the intervention program was effective, a single-factor reversal (ABAB) design was chosen. According to Bordens and Abbott (1999), a single-factor baseline design includes a basline condition (A) which the baseline is established, and an intervention condition (B) in which the treatment or intervention is observed. Further, Bordens and Abbott explain that a reversal strategy is used to determine whether the intervention actually caused changes in the behavior. Using a reversal design produced a total of four phases (ABAB). Therefore, the phases of the study were baseline-intervention-baseline-intervention. The first

phase was two weeks long to establish a solid baseline. The rest of the phases were each one week long.

Each phase required daily documentation of the duration of the identified target behavior by the subject's caregiver. Recording was accomplished using a chart created in a spreadsheet (see Appendix C). Each day, the caregiver recorded the subject's behavior during hair brushing (morning) and tooth brushing (evening). Through observation, the caregiver determined whether or not the subject had an "adverse reaction" (based on the predetermined definition of the adverse reaction). The behavior was then recorded and included crying, screaming, running, and hitting and he duration of the behavior was recorded. According to Richards et al. (1999), recording duration involves "measuring the length of time from when a behavior begins to its termination" (p. 63). Data was recorded for five weeks: Baseline for two weeks, intervention for one week, baseline for one week, and intervention for one more week. Once the data was collected, the researcher compiled the data into graphs for data analysis.

Intervention

The intervention used in the study was a brushing program that is commonly known as the Wilbarger Protocol (Wilbarger & Wilbarger 2002). A certified occupational therapist who has been trained to use the technique, and who knows sensory integration theory, taught the caregiver how to implement the Wilbarger Protocol and supervised until the technique was mastered. There is no written description of how the protocol should be applied because the developers believe that actual training is required to master the interventions (Wilbarger & Wilbarger, 2004). The protocol will be described in basic terms here, however, a more detailed description written by a certified occupational therpist can be seen in Appendix D.

There are two phases to the brushing protocol (Aquilla, Sutton & Yack, 2003). First, deep pressure is provided through the use of a surgical brush (no other type of brush should be used). Slow, methodical pressure is applied to the legs, arms, and back. Other body parts should not be brushed as it can cause adverse reactions. Following the brushing phase, the subject is given gentle joint compressions in the shoulders, elbows, wrists, fingers, hips, knees, ankles, and sternum. The complete routine takes approximately three minutes. Further, the protocol can be administered every two hours up to four times a day.

For the current study, it was recommended that the brushing program be initially implemented one to two times per day, or as tolerated. The program was implemented during the B or treatment phases of the study. The subject's mother implemented the program every morning before grooming activities and as needed throughout the rest of the day, but never more than twice per day.

Data Analysis

The method used for analyzing data was visual analysis, which is "a systematic form of examination used to interpret graphically displayed data' (Cooper et al., 2007). According to Richards et al. (1999), visual analysis is appropriate to use when continuous numerical data is gathered and graphed. This method is typically used to determine whether behavior changed in a meaningful way and whether or not the behavior can be attributed to the independent variable (Cooper et al., 2007). Cooper et al. recommended researchers examine four fundamental properties common to all behavioral data. These four properties were applied to the data set for this single subject research design:

1. Quantity of data collected during each condition
2. The extent and type of variability in the data

3. The level of the data

4. Trends in the data.

When using visual analysis, the researcher must first establish the quantity of data collected during each condition (Cooper et al., 2007). Simply, this means counting data points. Generally, the data is more valid with higher numbers of measurements of the dependent variable and a longer measurement period.

Next, the extent and type of variability was assessed. Cooper et al. (2007) described variability as "how often and the extent to which multiple measures of behavior yield different outcomes" (p. 150). Cooper et al. explain further that when all conditions during a given phase are held constant and several measures of the behavior demonstrate a large level of inconsistency, the behavior is said to display variability. Generally, if there is a large amount of variability within a given phase or condition, researchers can assume they have little experimental control over the behavior (Cooper et. al). Therefore, high variability is often present during baseline phases, and more data points are needed to show a consistent pattern of behavior. If the intervention is successful, variability decreases as the researcher gains experimental control over target behaviors. In this study, variability was calculated and summarized using tables and variability range lines as recommended by Engel and Schutt (2008). Engel and Schutt explain that range lines allow the reader to visually analyze the spread in the data.

Examining the level, or "value on the vertical axis scale around which a set of behavioral measures converge" (Cooper et al., 2007, p. 150) is the next step in visual analysis. The researcher used mean level lines to provide a summary of average performance within each of the given phases. A mean level line is a "horizontal line drawn through a series of data points

within a condition at that point on the vertical axis equaling the average value of the series of measures" (Cooper et al., p. 151). A mean level line is often used when the data points have high variability.

Finally, trends in the data must be examined. According to Cooper, a trend is "the overall direction taken by a data path…and are described in terms of their direction, degree of magnitude, and extent of variability of data points around the trend" (p. 151). Trend lines were examined in two ways using Microsoft Excel linear trend lines. First, an overall trend line was drawn from the first data point to the last in order to examine the general trend of the whole study. In addition, individual trend lines for each phase (ABAB) were drawn and examined to compare trends between conditions.

The data from the duration recording were transferred to graphs (See Figures 1-8). The graphs were then examined using these properties. Results are discussed in the following chapter.

Chapter IV: Results

The purpose of this study was to examine the effectiveness of a brushing program for a child with tactile defensiveness. The duration of the subject's adverse reaction to specified grooming events (hair brushing and tooth brushing) was measured through baseline and treatment phases, using a single-factor reversal (ABAB) design. Then, visual analysis was used to assess the effectiveness of the brushing program with the identified subject by examining the variability, mean level, and trends lines across all four phases. This chapter will discuss the results of the study in terms of the four research questions proposed in the introduction.

Research Question 1: What degree of variability did the target behavior show across research conditions?

In order to show experimental control, or lack of control, over the target behavior, variability was examined (Cooper et al., 2007). Figure 1 and Table 1 display the level of variability in each phase of the hair brushing portion of the study. All conditions were one week in length, with the exception of the first baseline, which was two weeks long. The first baseline also shows the greatest amount of variability (15 minutes). This condition was two weeks long due to the high variability of the subject's behavior in the first week of data collection both with hair brushing and tooth brushing. Once the first treatment phase began, the variability decreased to five minutes. The second baseline showed no variability. In fact, during the second baseline, the subject did not show any adverse reaction to hair brushing. The second treatment condition showed a slight increase in variability (5 minutes).

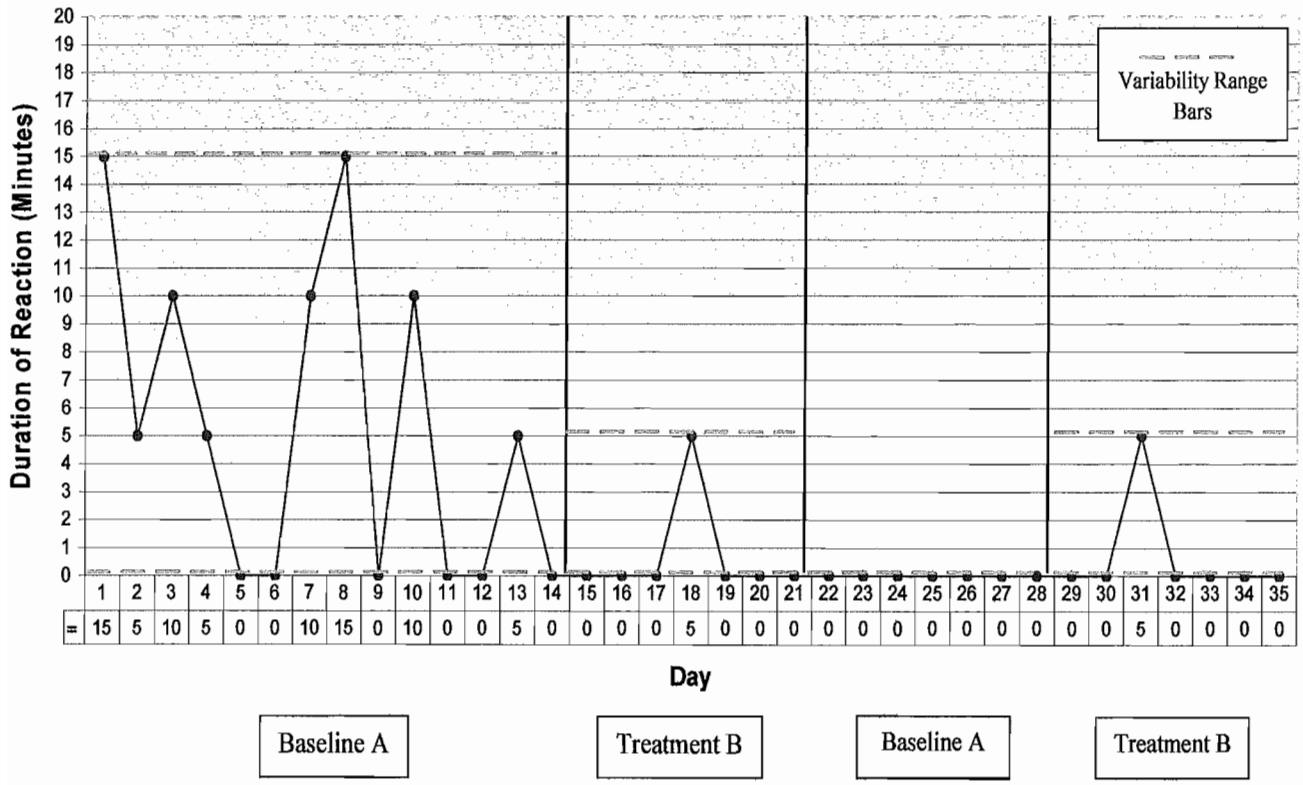

Figure 1. Line graph displaying the variability of the duration in the subject's adverse reaction to hair brushing using range bars.

Table 1

Range of the Duration (In Minutes) of the Subject's Adverse Reaction to Hair Brushing (By Condition)

Condition	High	Low	Difference/Range
Baseline 1	15	0	15
Treatment 1	5	0	5
Baseline 2	0	0	0
Treatment 2	5	0	5

Figure 2 and Table 2 display the level of variability in each phase of the tooth brushing portion of the study. Again, all conditions were one were one week in length, with the exception of the first baseline, which was two weeks long. As with the hair brushing portion of the study, the first baseline condition for tooth brushing showed the greatest amount of variability in the subject's behavior (10 minutes). However, for the next three phases, the subject displayed no behaviors associated with the defined adverse reaction.

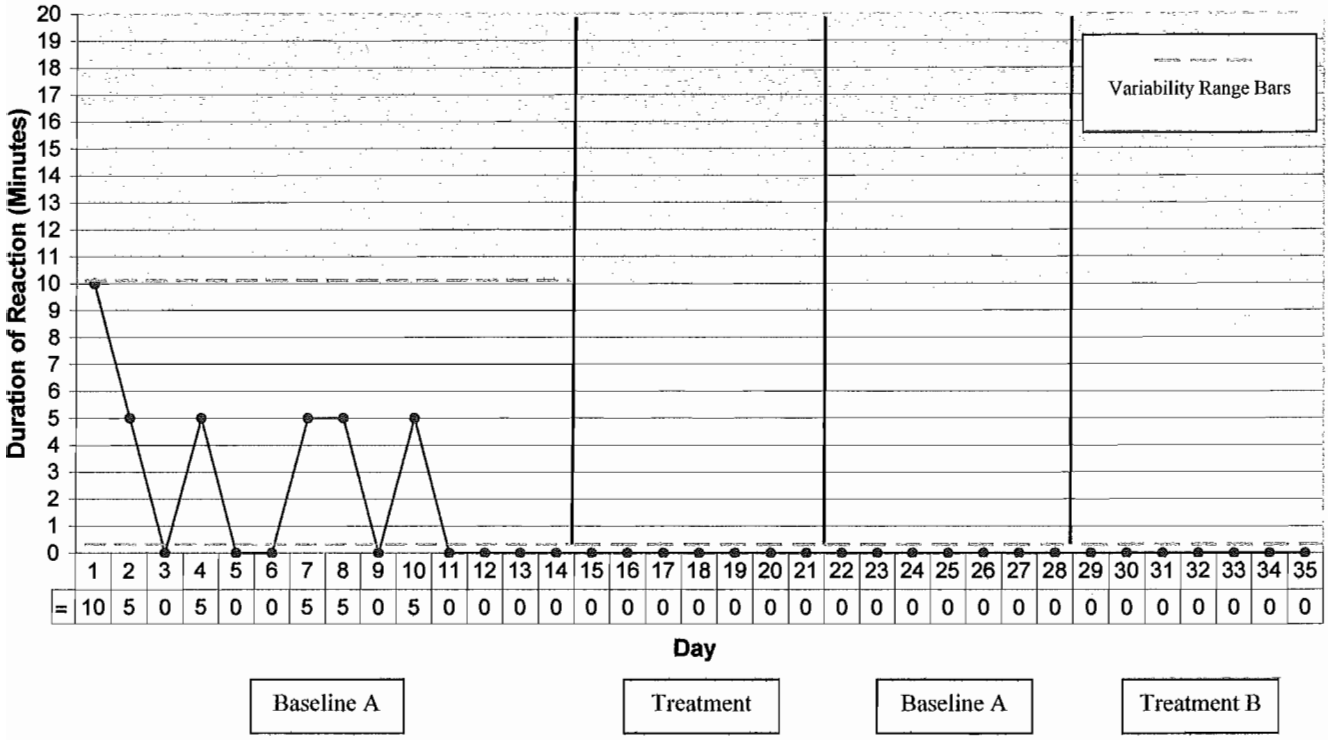

Figure 2. Line graph displaying the variability of the duration in the subject's adverse reaction to tooth brushing using range bars.

Table 2 *Range of the Duration (In Minutes) of the Subject's Adverse Reaction to Tooth Brushing (By Condition)*

Condition	High	Low	Difference/Range
Baseline 1	10	0	10
Treatment 1	0	0	0
Baseline 2	0	0	0
Treatment 2	0	0	0

Research Question 2: What was the level of the target behavior across baseline and treatment conditions?

Mean level lines were used to calculate and show the average duration of the adverse reaction across all conditions. Figure 3 is a line graph displaying the mean levels across all conditions in the hair brushing portion of the study. It should be noted that Cooper et al. (2007) do not recommend using mean level lines for relatively stable behavior; however, they are shown for all conditions here in order to maintain consistency. The mean duration of the subject's adverse reaction to hair brushing in the first baseline condition was 5.4 minutes. During the first treatment condition, the mean duration of her behavior dropped to .71 minutes. During the second baseline condition, the duration of her behavior dropped to an average of zero minutes (no reaction to hair brushing at all), and rose again to an average of .71 minutes the last week of the treatment condition.

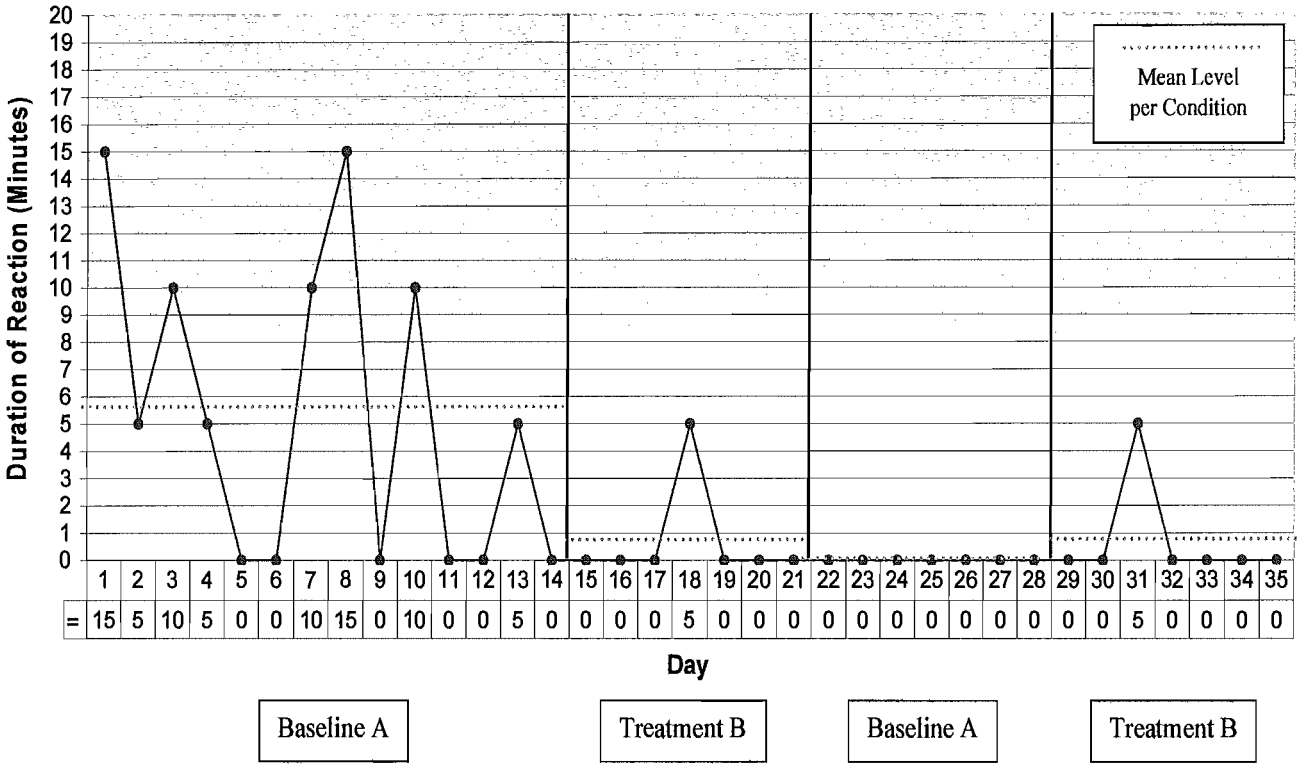

Figure 3. Line graph depicting mean levels of the target behavior for each condition of the hair brushing portion of the study.

Figure 4 is a line graph displaying the mean levels across all conditions in the tooth brushing portion of the study. In this portion, the mean duration of the subject's adverse reaction to tooth brushing in the first baseline condition was 2.5 minutes. During the last three phases of the study (treatment, baseline, treatment), the subject displayed no adverse reaction when brushing her teeth.

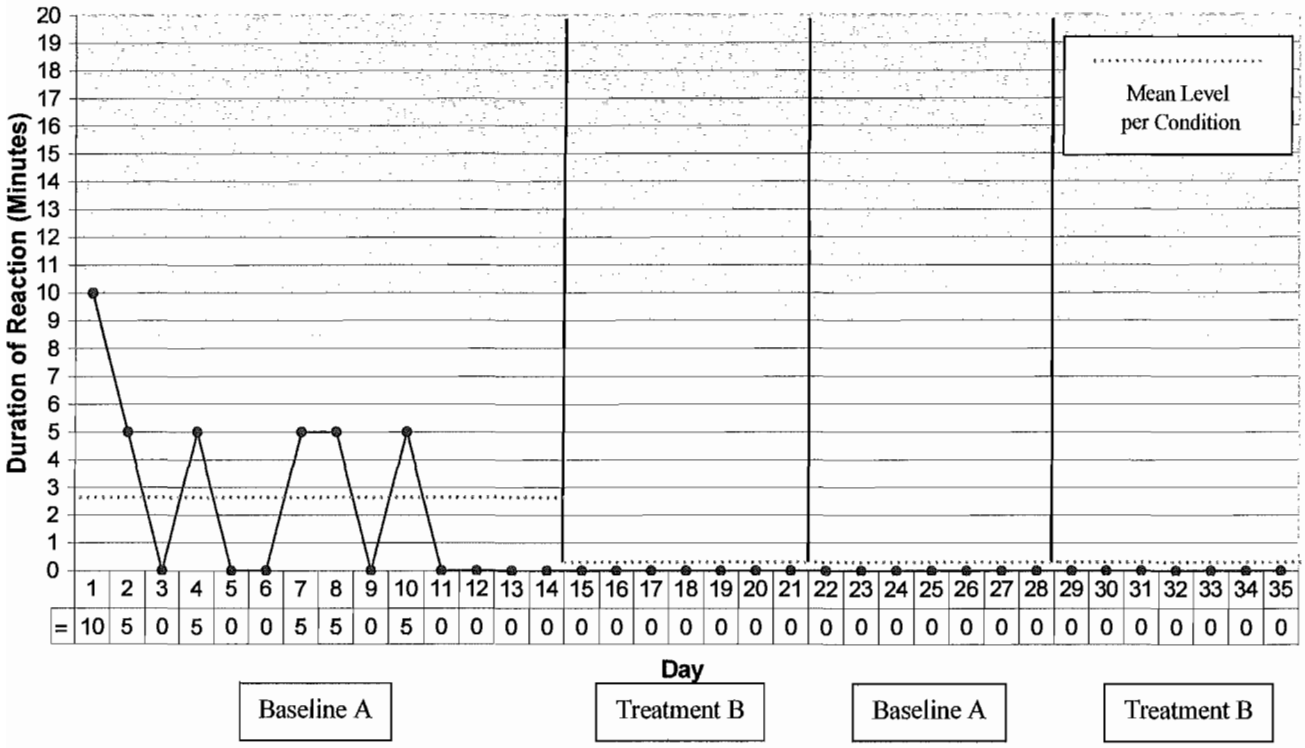

Figure 4. Line graph depicting mean levels of the target behavior for each condition of the tooth brushing portion of the study.

Research Question 3: What trends did the target behavior demonstrate across baseline and treatment conditions?

Microsoft Excel was used to calculate trend lines for both the hair brushing and tooth brushing portions of the study. Trend lines were analyzed in two ways. First, a trend line was calculated and drawn using the data from the entire course of the study. Then trend lines were calculated and drawn for each individual research phase of the study for both tooth brushing and hair brushing.

Trend line data for the hair brushing condition can be found in Figures 5 and 6. A visual inspection of the trend line in Figure 5 reveals that there was an overall decrease in the subject's adverse reaction to hair brushing over the course of the study. The decrease appears to be relatively gradual over time. However, Figure 6 depicts trend lines for each condition of the

study. During the first baseline condition, there is a sharp decrease in the subject's behavior. During the subsequent conditions (B, A, B), the subject's adverse reaction had nearly completely disappeared, so the trend lines represent very low levels.

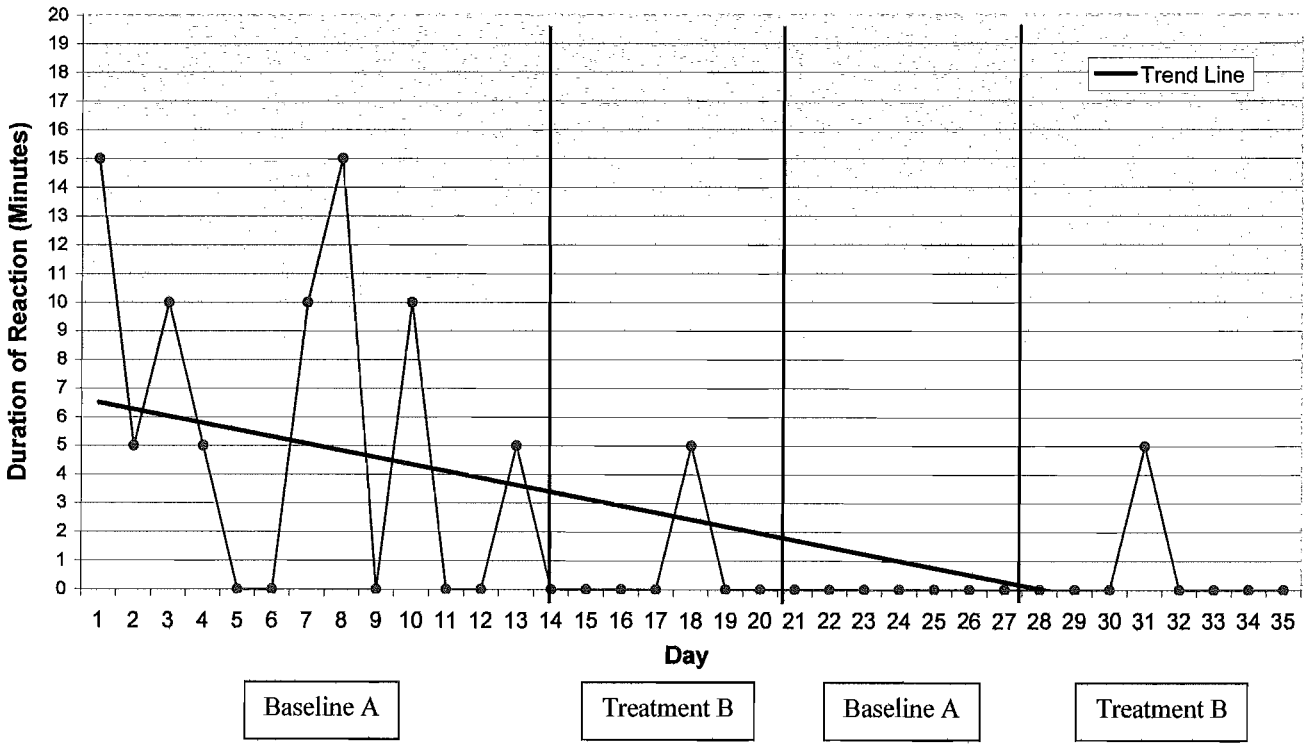

Figure 5. Line graph depicting trend line data for the course of the hair brushing portion of the study.

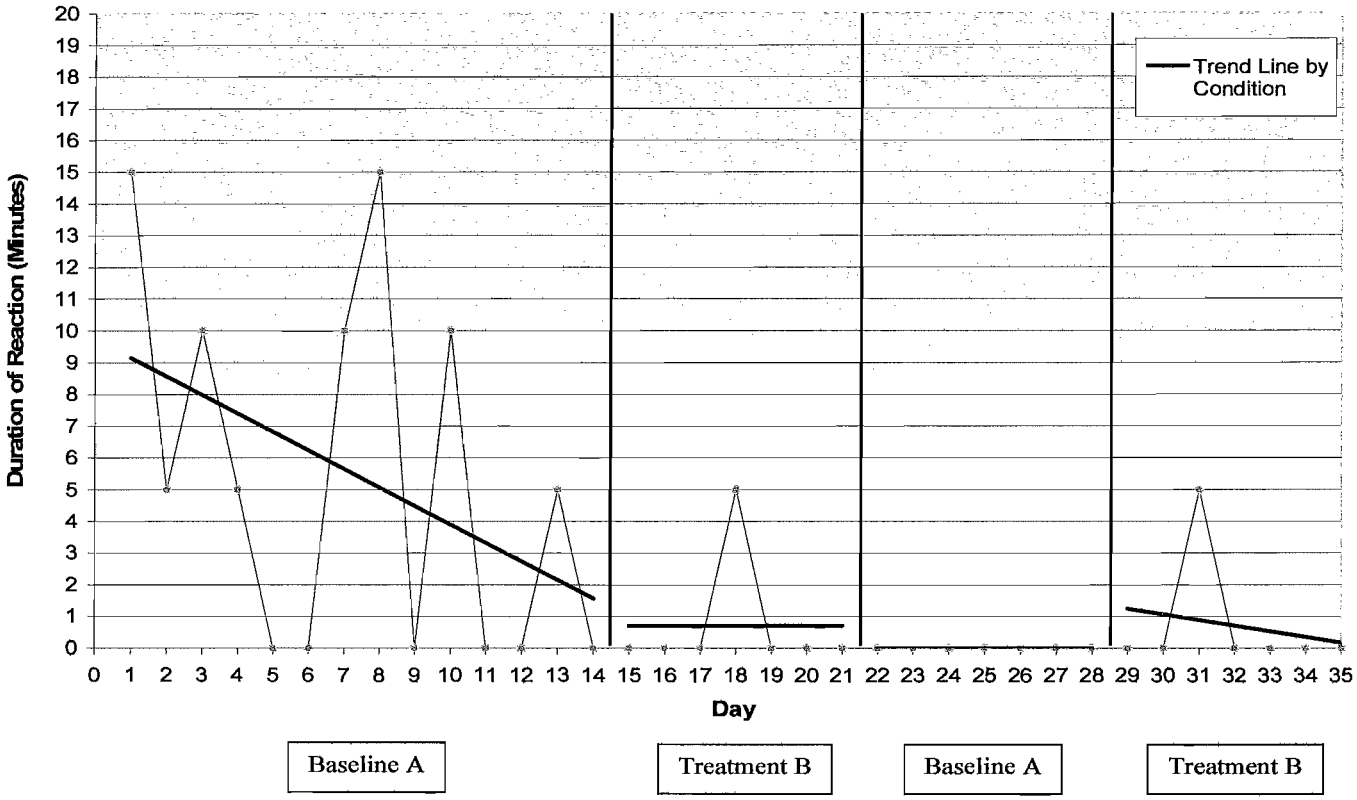

Figure 6. Line graph depicting trend line data by condition for the hair brushing portion of the study.

Trend line data for the tooth brushing condition can be found in Figures 7 and 8. As with the hair brushing condition, a visual inspection of the trend line in Figure 7 indicates an overall decrease in the subject's adverse reaction to brushing her teeth. The decrease appears to be even more gradual than the hair brushing condition. However, upon inspection of the weekly trend lines in Figure 8, it is evident that the behavior was already decreasing across the first two weeks of the baseline phase, and completely disappeared once treatment started. The behavior never reappeared for the rest of the study, therefore, the trend lines for the subsequent conditions (B, A, B) are flat.

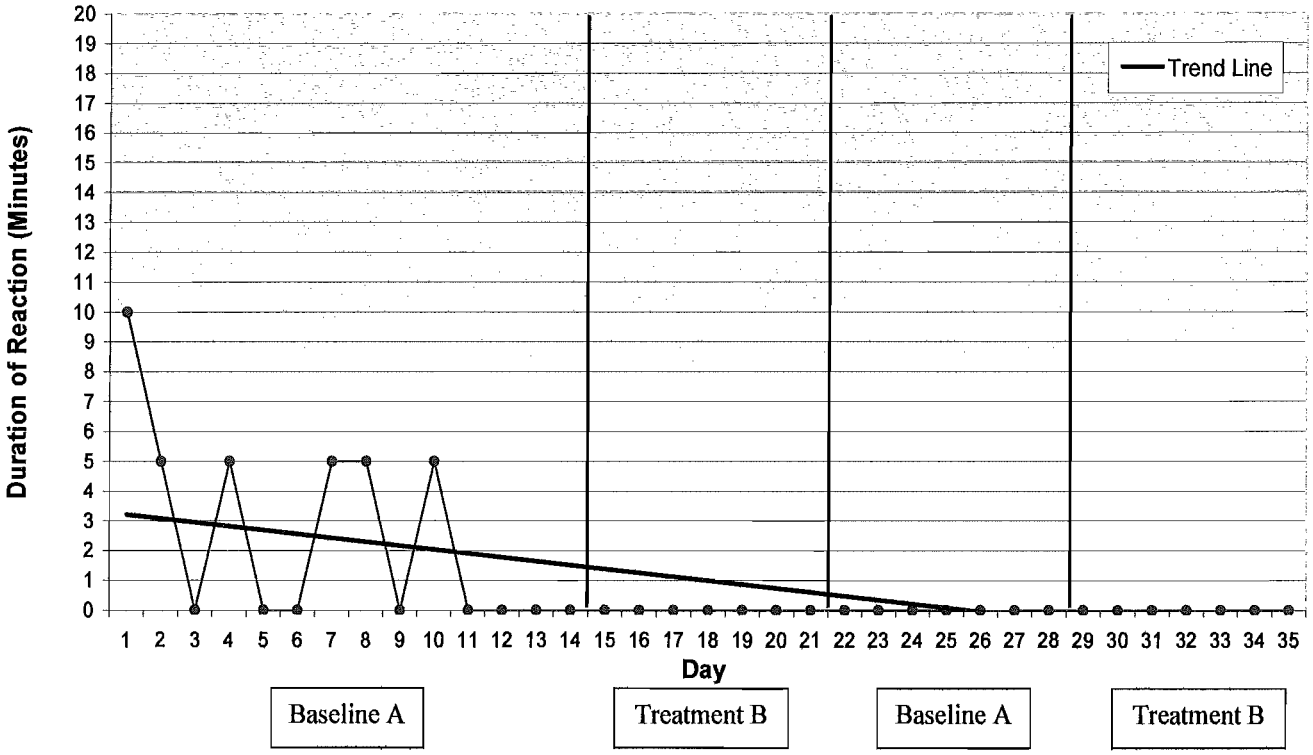

Figure 7. Line graph depicting trend line data for the course of the tooth brushing portion of the study.

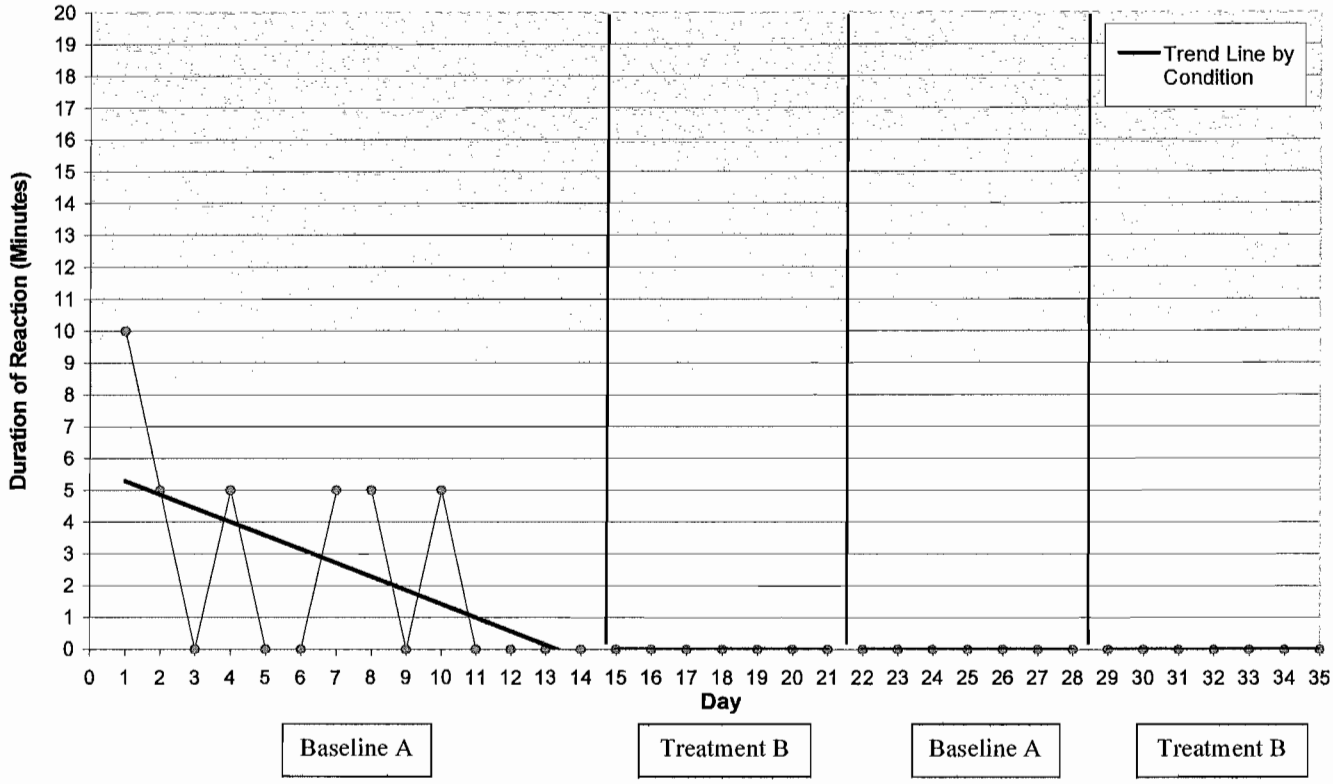

Figure 8. Line graph depicting trend line data by condition for the tooth brushing portion of the study.

Research Question 4: Was the Wilbarger Protocol effective on the target behavior?

Initial examination of the data might indicate the Wilbarger protocol was effective in reducing the duration of the target behavior. The variability decreased after the initial baseline phase in both the hair and tooth brushing portions of the study, indicating experimental control over the behavior (See Figures 1 and 2). Further, mean level lines also decreased during both initial treatment phases, indicating lower levels of the target behavior (See Figures 3 and 4). In addition, the data shows an overall decreasing trend in the duration of adverse reactions in both the hair brushing and tooth brushing portions of the study (See Figures 5 and 7).

However, deeper examination of the data does not indicate clearly whether the Wilbarger Protocol was the cause of the decrease in the duration of the target behavior. Two pieces of

evidence in the data indicate the results are inconclusive. First, an examination of the reversal in the research design questions the effect of the Wilbarger protocol. In week four, a second baseline was collected. In order to show effectiveness of treatment, researchers would expect that the undesirable target behavior would increase in duration and variability during the reversal, just as in the initial baseline (Cooper et al., 2007; Engel & Schutt, 2008; Richards et al., 1999). In this study, however, no adverse reaction to either grooming event was observed during the second baseline. In fact, the data in the second baseline is very similar to that of the second treatment phase, indicating the level of adverse reaction remained relatively stable. No reaction was observed to brushing teeth during the entire week, and only one five-minute incident occurred during the entire week of hair brushing.

The significant drop in mean level lines and variability could imply that one week of intervention completely extinguished the adverse reaction associated with grooming activities, which would explain why there was not an increase during the second baseline phase. However, a second piece of evidence shows that this conclusion is inaccurate. An analysis of the trend lines from individual research phases for both hair brushing and tooth brushing showed a significant decrease in duration as even the first baseline progressed (See Figures 6 and 8). In other words, over the 14 days of baseline, adverse reactions to both activities decreased at a rapid rate, without presence of intervention. This finding indicates that the behavior began to diminish before the intervention started.

Both an analysis of the reversal in the design and an examination of the individual trend lines by phase demonstrate the difficulty in determining whether the Wilbarger Protocol was the reason for the decline in the subject's adverse reaction to grooming activities. The following chapter will discuss possible scenarios for this change.

Chapter V: Discussion

The purpose of this study was to examine the effectiveness of a brushing program for a child with tactile defensiveness. Data regarding the duration of the subject's adverse reaction to grooming activities (hair and tooth brushing) was collected and graphed. Visual analysis was used to examine the data and subsequent effectiveness of the brushing program with the identified subject. This chapter will discuss the major conclusions of the study as well as its limitations, suggestions for future research, and implications for practice.

Conclusions

The literature review indicated mixed results regarding the efficacy of sensory integration interventions. Meta-analyses showed that early studies (before 1980) produced favorable results, while studies conducted later had less favorable results (Ottenbacher, 1982; Vargas & Camilli, 1998). Many studies have been conducted using parent perception as the basis for measuring efficacy (Mulcahy, 1994; Cohn, 2000), instead of observing and recording target behaviors.

The current study used an operationalized definition of specific behaviors associated with sensory defensiveness, thereby creating more control over measuring the effectiveness of a brushing program. This study looked at variability of the behavior, mean levels, and trend lines to determine whether the intervention was successful. The first part of this chapter will discuss the major findings of the study.

In terms of variability in both the hair brushing and tooth brushing sections of the study the subject demonstrated a large degree of variability in her behavior during the first baseline phase. In fact, the researcher decided to add time to this phase in order to establish a stronger pattern of behavior. Further, during the rest of the study, beginning with the first treatment phase, the subject demonstrated much less variability in her behavior. The subject's negative

reaction to tooth brushing seemed to be extinguished immediately during the first treatment phase and never returned.

Mean levels and trend lines indicated that the subject demonstrated unanticipated patterns of behavior. The mean levels in both the hair brushing and tooth brushing sections of the study showed the highest levels of negative behavior during the first baseline phase, although the behavior decreased over time. During the first treatment phase, the reaction to tooth brushing completely disappeared and did not return for the rest of the study. The reaction to hair brushing continued to diminish in the first treatment, disappeared during the second baseline, and reappeared briefly during the last treatment phase.

These findings were used to drive the fourth research question which asked whether the Wilbarger Protocol was effective on the target behavior. Overall, the data did not indicate a clear determination about whether the intervention was successful. Initial examination indicates the target behaviors became less variable and largely diminished once the first treatment phase began. These preliminary findings might lead to the conclusion that the Wilbarger Protocol created experimental control over the behavior and decreased the duration. However, closer examination of the reversal in the design shows that the second baseline did not produce high variability or increased levels in the target behavior. This finding calls into questions whether it was indeed the Wilbarger Protocol that created the initial change. One could argue that the target behavior did not reappear upon the second baseline because first phase of intervention completely extinguished the adverse reaction. However, trend lines drawn for each phase of the design reveal that the behavior began to decrease rapidly during the first baseline phase, even without any intervention.

Results Synthesized with Literature Review

It is unclear whether the intervention actually helped to diminish the behaviors, or whether the subject was already demonstrating a decrease in the behaviors on her own. The latter theory is consistent with research by Cermak and Henderson (1990) who noted that some professionals take a maturational stance. These professionals propose that children will eventually "grow out" of sensory integration dysfunction. Because the subject was six years old, one needs to consider that she was growing and developing at a relatively rapid rate. Children of this age change quickly, and so do their abilities to make sense of the world around them. It is possible that during this study the subject was developing a way to cope with her sensory defensiveness, or was "growing out" of that particular over-reaction to tactile stimuli. Upon interviewing the subject's caregiver, it was noted that while the subject showed a definite decrease in adverse reactions to grooming activities, she also demonstrated an increase in a need for oral stimulation at other times during the day. The subject had begun to chew on inappropriate items such as her clothing, which could indicate a shift in her sensory needs or that she was self-modulating by chewing. Any of these conclusions might be explained by a developmental change in the subject.

If the intervention was indeed successful and was able to all but extinguish the adverse reactions, these results would somewhat align with research by Kearns (2004) who found an increase in positive behaviors after art therapy sessions. However, the current study did not measure the level of positive behaviors; it only measured the level of negative behaviors. Results may also align with those found by Mulcahy (1994) who found positive effects from sensory integration therapy. However, in that study, the positive results were much slower to appear. Finally, if the brushing intervention was the cause of the behavior change, these results

would align more with Ottenbacher's meta-analysis in 1982 which found more positive effects from sensory integration therapy than negative.

Because the results of this study are truly unclear, they are most consistent with the views put forth by Miller (2003) who explains that while sensory integration techniques are not backed by consistently positive research, they have not been proven ineffective, either. It is difficult to determine whether a particular sensory integration technique is truly the cause of behavior change since children come into contact with dozens of sensory experiences throughout their day. It is important to note that the subject's mother did report the subject requested brushing after the study concluded. This might indicate that, while the results were inconclusive, the intervention did appear to have a positive effect on the subject.

Limitations

Although the researcher attempted to assert as much control as possible over this study, several limitations may have interfered with obtaining clear and accurate results. These limitations include, but are not limited to, a lack of control over the natural setting and using a third party for data collection Further, due to the single-subject design, the results of this study may not be easily generalized to a larger population.

While it was important to conduct this study with the subject in her natural setting, this environment also introduces several variables that could not be controlled. In a natural environment, it was necessary for the subject's caregiver to implement the intervention, rather than the researcher herself. While the mother was trained extensively in the implementation of the brushing program by an occupational therapist, it is unknown whether certain factors and or unconscious biases may have interfered with the program. For example, because the mother knew she had to collect data, she may have approached her daughter more gently than typical

during treatment phases, which in turn may have affected her daughter's behavior. Conversely, on days where the treatment was not administered, the mother may have approached her daughter in a different manner and could have evoked yet other behaviors. Because this study was conducted in the subject's natural environment, it was impossible to observe these nuances in the relationship between mother and daughter.

Further, it was impossible for the researcher to directly observe, measure, and record the behavior. Therefore, the data was obtained on the basis of clear expectations and trust in the caregiver. While the mother knew how to implement the intervention and collect the data, her role as the subject's caregiver creates a natural bias in her observation and evaluation of the behavior. She may have observed more calm behavior during treatment and/or more elevated behavior during baseline based on a preconceived idea of what the results were supposed to look like.

Finally, the results of this study may not be easily generalized to a larger population, given its single-subject design (Richards et al., 1999). The study examined sensory integration therapy specifically on a young child with tactile defensiveness. More studies would need to be conducted with similar subjects and interventions in order to show a pattern of effectiveness, thereby making the results more easily generalized.

Suggestions for Future Research

This study examined the effectiveness of a brushing protocol on a child with sensory defensiveness in her natural setting. While it is important for research to be conducted natural settings, the prevalence of extraneous variables also increases (Richards et al., 1999). Similar studies conducted in the future would be better controlled if the researcher was able to collect the data. Conducting a similar study in a school setting with the researcher implementing the

intervention and collecting data would provide more overall control over the study. It would decrease the chances for observer bias and deviation from standard implementation of the intervention. Further research should also consider logging variables that may interfere with the child's day such as changes in schedule, amount of sleep and diet. These variables could have a significant impact on the subject's behavior. Logging the prevalence of these variables would allow for more control over the study; and, therefore logging would make results more clear.

Implications for Practice

While the nature of this study appears to apply more to the field of occupational therapy, it is also an important topic for school psychologists. Sensory integration issues are reported as highly prevalent in children with autism spectrum disorders (ASD). With the increasing rate of ASD diagnoses in the United States, it is important that school psychologists are aware of interventions that are effective for students with ASD. Sensory integration is one such intervention that is growing in use in public schools.

In addition, special education has evolved into a strong interdisciplinary team approach used to serve children with disabilities. It is not uncommon to have a team of professionals serving a child that includes parents, teacher(s), psychologist, speech/language pathologist, occupational therapist, physical therapist, and/or adapted physical education instructor. It is important for these professionals to have the ability to work collaboratively to create the most effective program for each child. Therefore, it is important for school psychologists to have a basic understanding of services and interventions that the interdisciplinary team has to offer.

Finally, this study was conducted using a smaller version of the above described interdisciplinary team. In order for the study to be conducted in the subject's natural environment, a team of people should be involved. For instance, the subject's caregiver needed

to implement the intervention and collect data because she is in the child's natural environment. The occupational therapist also needed to be involved because she had the expertise with the intervention and was the only member of the team qualified to train someone in the implementation. Finally, because school psychologists have expertise in behavioral data collection and analysis, the school psychologist was able to create the research design and assess the effects of the intervention. School psychologists are also trained in looking at a student/child holistically, so data could be analyzed and interpreted more thoroughly.

Summary

Behaviors associated with sensory integration dysfunction are often problematic in the home and school settings. Since the identification of this disorder in the 1970s (Ayres, 1972), occupational therapists have searched for interventions to help with these problematic behaviors. The purpose of this study was to examine the effectiveness of a specific sensory integration technique: the Wilbarger Protocol. Results of this single-subject study proved to be inconclusive. The subject's negative behaviors decreased over the course of the study; however, it was unclear whether this decrease was due to the intervention or a variety of other extraneous variables. Further research should consider conducting a similar experiment in a school setting with more control over observation and data collection.

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Appendix A: Memo to Colleagues

Dear Colleague,

I am currently working on a thesis project as part of a requirement for the Education Specialist (Ed.S.) degree at the University of Wisconsin-Stout. The title of the project is "An Examination of a Brushing Program for a Child with Sensory Sensitivity." The goal of the research is to examine the effectiveness of an intervention that addresses behaviors that may be a result of difficulties with sensory integration. The first step in carrying out this research is to locate children who may be experiencing difficulty with sensory integration. I am requesting that children be recommended to me if they display several of the following behaviors:

- Avoidance of certain textures, specifically those that are scratchy or rough
- Unusual preference for certain textures (soft, smooth)
- Likes to keep body well covered, even in warm weather (wears long pants and long sleeves)
- Likes to stand at the end of lines in order to avoid physical contact with others
- Pulls away from anticipated touch from others, especially with contact near the face
- Aversive responses to non-noxious touch such as hugging, bathing, cutting fingernails, and face washing.
- Aggression towards light touch
- Initiates/seeks hard or deep pressure (pushing into walls or other people)
- Likes to give "bear hugs" or lays on top of other children
- Actively avoids playing activities which involve varying textures such as play dough, finger painting, or any other activity that may be messy
- Avoids or controls play activities that involve body contact
- Plays by his or herself
- Is rigid and likes routine. Gets upset when the routine is altered
- Likes to have control over situations in which touch is anticipated

If you recommend a child for the study, his or her parents will be contacted in order to gain permission to use a rating scale which will measure sensory integration difficulties in their child. Of the children who are recommended, the child who shows the most difficulties with sensory integration will be selected to undergo the remainder of the study. Parents will again be contacted in order to gain further permission for the rest of the study

If the child you recommend is selected to undergo the remainder of the study, he/she will participate in some sensory activities and interventions. These interventions will hopefully have a positive effect on how the child interacts with his/her environment. You may be asked to help with some of the interventions, and the child may need to be absent from a small amount of class time (less than 3 hours per week) to be involved in the activities.

I appreciate your cooperation and assistance in this thesis project. If you have any questions regarding behaviors, interventions, or about the thesis project, please contact me at davichj@uwstout.edu, or 651-555-1234.

Sincerely,

Jessica Davich, M.S. Ed.

Appendix B: Parent Consent

UW-Stout Signed Consent Form for Research Involving Human Subjects
Consent to Participate In UW-Stout Approved Research

Title: An Examination of a Brushing Program for a Child with Sensory Sensitivity

Investigator:
Jessica Davich
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Research Advisor
Kelly Lamon
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Description:
The principle investigator is asking for permission to assess the sensory needs of your child, implement a brushing program, and evaluate the effectiveness of this intervention. This involves collecting behavioral data, being trained by an occupational therapist regarding how to implement the program, implementing the program daily, and meeting with the investigator to evaluate the effectiveness of the program. The case will then be used as a single-subject research design for the principle investigator's thesis.

Risks and Benefits:
The goal of this study is to help the subject of this project reduce behaviors related to sensory integration dysfunction and to reduce sensitivity to sensory input. The subject will benefit from the assessment and intervention, and her behaviors of concern will likely improve. Furthermore, this study is important to the field of occupational therapy and education. Sensory integration theory proposes that providing particular sensory experiences in a controlled manner can reduce sensitivity and/or defensiveness. However, the research regarding the effectiveness of specific interventions is limited.

The brushing program itself does not have the potential to harm a child. Brushing is light and not painful at all. However, because of certain children's defensiveness to tactile stimulation, the child might show adverse behaviors related sensitivity. If this is the case, treatment will be stopped immediately or the plan will be evaluated or changed.

Special Populations:
The subject for this project is your child, a minor. Therefore, signed consent is needed from you, the parent.

Time Commitment and Payment:
There is no payment. There will be a time commitment involving daily recording of a target behavior. In addition, you will be required to implement intervention on a daily basis for the duration of the investigation (approximately 4-6 weeks).

Confidentiality:
You and your child will not be identified by name on any documents used for the thesis. This informed consent will not be kept with any of the other documents completed with this project. Documents with the child's name will be kept in a confidential file secured by the investigator.

Right to Withdraw:
Your child's participation in this study are entirely voluntary. Without any adverse consequences, you the parent, may choose not to have your child participate in the study, and the investigation will be stopped.

IRB Approval:
This study has been (will be) reviewed and approved by The University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator.

Investigator:
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587-0802

Advisor:
Kelly Lamon
715-232-2569

IRB Administrator
Sue Foxwell, Director, Research Services 651-152 Vocational Rehabilitation Bldg.
UW-Stout
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foxwells@uwstout.edu

Statement of Consent:
By signing this consent form you agree to have your child involved in a sensory needs assessment, intervention, and evaluation. You also are consenting to allow Jessica Davich the ability to write up the project entitled, An Examination of a Brushing Program for a Child with Sensory Sensitivity for her thesis.

_____

Parent Signature Date

Appendix C: Data Recording Chart

Day 1	Type of Grooming	Hair Brushing	Tooth Brushing
	Adverse Reaction? Yes or No and Description of Behavior		
	Duration		
Day 2	Type of Grooming	Hair Brushing	Tooth Brushing
	Adverse Reaction? Yes or No and Description of Behavior		
	Duration		
Day 3	Type of Grooming	Hair Brushing	Tooth Brushing
	Adverse Reaction? Yes or No and Description of Behavior		
	Duration		
Day 4	Type of Grooming	Hair Brushing	Tooth Brushing
	Adverse Reaction? Yes or No and Description of Behavior		
	Duration		
Day 5	Type of Grooming	Hair Brushing	Tooth Brushing
	Adverse Reaction? Yes or No and Description of Behavior		
	Duration		
Day 6	Type of Grooming	Hair Brushing	Tooth Brushing
	Adverse Reaction? Yes or No and Description of Behavior		
	Duration		
Day 7	Type of Grooming	Hair Brushing	Tooth Brushing
	Adverse Reaction? Yes or No and Description of Behavior		
	Duration		

Appendix D: Overview of Wilbarger Protocol

Overview of Wilbarger Protocol for Sensory Defensiveness
Written by Lois Schalesky, Certified Occupational Therapist

Preparation for Wilbarger Brushing Program:

A brushing program must be implemented with thorough training from an accredited occupational therapist. Consultation is advised before implementation of these procedures. A brushing program involves a commitment of complete brushing and joint compression every 2 hours and up to four times each day. Consult an accredited occupational therapist for revisions to this programming.

- Environmental suggestions: location should be devoid of extreme visual and auditory distractions, lighting should be low and/or muted, soft-rhythmic music is suggested, comfortable up-right seating, and clothing which exposes skin surfaces (Shorts, tanks and/or t-shirts, and no shoes or socks if possible. Note: these procedures can be done over clothing with moderate effectiveness).
- Explain that you will be doing a "brushing program" with the student and ask "may I use this brush on your back, arms, and legs?" (showing the brush to the student) If the student shows any apprehensiveness, suggest he/she take the brush and self-apply it to rub on palms of hands or on the back of arms to become comfortable with the procedure.
- Once the student appears comfortable with the procedure state, "I will be placing my hand on your shoulder lightly as we use the brush".
- Have student sit, with arms hanging and relaxed and feet flat on floor with muscles in relaxed position. The student can be sitting slightly forward on chair or can lean slightly forward to allow for availability of spinal cord.

Upper Extremity:

- If right-handed, place left hand gently on subject's left shoulder and, with right-hand, brush with deep-vigorous motions on surface of the back of the student's neck (about 10 strokes).
- Continue brushing with deep-vigorous strokes up and down spinal cord and over full surface of back (about 10 strokes).
- While maintaining constant contact with right hand on left shoulder, reposition left hand to boney protuberances of subject's left wrist. Begin deep-vigorous brushing up and down full length of left arm. Finish with brushing of inner arm and then back and palm of hand (about 10 strokes).
- While maintaining constant contact with right hand on right shoulder, reposition left hand to boney protuberances of subject's right wrist and repeat brushing as stated for left side.

Lower Extremity:

- While maintaining constant contact with right hand on subject's right knee, reposition left hand to boney protuberances of subject's right ankle. With right hand brush with

deep-vigorous motions over full length of the front surface of right leg. Continue with brushing over back of leg, top and bottom of foot.

- While maintaining constant contact with right hand on subject's left knee, reposition left hand to boney protuberances of student's left ankle and repeat brushing procedure. Set aside brush.

Joint Compression of Upper Extremities:

- As you maintain constant contact place right hand gently on subject's right shoulder. With left hand gently grasp bone of arm just above elbow. Compress bone of arm into shoulder joint, attempting not to move skin or muscle but moving bone into joint (10 compressions).
- Reposition right hand to boney protuberances of wrist and reposition left hand to the area just above elbow. Compress arm into elbow joint gently. Grasp subject's hand with left hand and compress into wrist. With each digit of fingers and thumb, gently press into hand (10 compressions).
- Reposition to left side and repeat compressions.
- Note: if the student is of larger size or demonstrating hyper- or hypo-tonia, then "Wall Push Ups" can be substituted for over-all upper joint compression (to be done 10 times).

Lower Extremity Joint Compressions:

- For lower extremities, the above procedure is repeated with stabilization of hip to knee, knee to ankle, and toes into ankle. This must be done with solid stabilization and is recommended for younger students. If the subject is demonstrating hyper- or hypo-tonia and is able to perform "Jumping Jacks" or "Zulu Jumps", then it is advised to use these exercises about 5 to 8 times for over-all lower extremity compressions.
- An alternative to torso-compression, would be to stand directly behind the subject and place hands gently on the student's shoulders. Steadily lean on the shoulder, gently pressing downward about 5 times.
- Allow for a 5 to 10 minute "calming period" during which the student can remain motionless and in a relaxed position.